DOCUMENT RESUME

ED 192 923 PS 011 754

AUTHOR Townes-Rosenwein, Linda
TITLE The Relationship among Localization Skill, Existence Constancy and Object Permanence.
PUB DATE Sep 80
NOTE 31p.: Paper presented at the Annual Meeting of the American Psychological Association (88th, Montreal, Quebec, Canada, September 1-5, 1980).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Cognitive Development: *Infants: *Object Permanence
IDENTIFIERS *Piagetian Theory

ABSTRACT

Two component skills of object permanence were studied: existence constancy -- the infants' ability to expect that an object continues to exist after it is hidden, and localization skill -- infants' ability to search in the correct place for a hidden object. Contradictions within the literature may occur because of task lability caused by failure to: (1) study the two skills within traditional object permanence tasks, (2) examine more than one task, (3) study the two skills intra-individually, and (4) examine modality effects. These design faults were corrected in the present study. Four conditions in which the amount of information available about the object varied were designed to test Piaget's theories about object permanence and evaluate results obtained in non-traditional object permanence tasks. Eighty infants, randomly assigned to one of four groups, were tested at 4 and again at 8 months of age. Three of the groups consisted of the following experimental conditions: (1) Piaget's traditional test situation in which no sound emanated from the object; (2) sound emanating from the hidden object throughout the task; and (3) intermittent sound emanating from the object only while the object was in view. In the control condition, the object was never hidden from the infant's view. Infant behavior was scored from videotapes. Localization skill was measured by examining the order and location of infants' search. Existence constancy was measured by examining whether infants turned attention to the object after uncovering it. Data were consistent with Piagetian Theory. Existence constancy results were more similar to object permanence results than localization results. Haptic results were hierarchical (most individuals either passed or failed both skills), and infants made expected localization errors in invisible displacement trials. (Author/SS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

The Relationship among Localization Skill, Existence Constancy and Object Permanence

Linda Townes-Rosenwein, Lehigh University*

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY Linda Townes-Rosenwein TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED192923

Abstract

The young infant's cognitive organization may be unstable. This notion constitutes this study's approach to the developmental relationship among object permanence and two of its component skills: existence constancy, infants' ability to expect that an object continues to exist after it is hidden, and localization skill, infants' ability to search in the correct place for a hidden object. Contradictions within the literature may occur because of task lability caused by failure to: 1) study the two skills within traditional object permanence tasks, 2) examine more than one task, 3) study the two skills intra-individually, and 4) examine modality effects.

The research controls this lability in infants of 4 and 8 months. Four conditions vary the amount of available information about the object. Measures of both component skills are mutually independent.

Data are consistent with Piaget: 1) existence constancy results are more similar to object permanence results than localization results (since Piaget believes existence constancy is a core concept of object permanence, their results should be more similar), 2) haptic results are hierarchical (most individuals either pass or fail both skills), 3) infants make expected localization errors in invisible displacement trials. However, the Stage IV error doesn't occur. Implications of lability are discussed.

PS011754

---

*Paper presented at the meeting of the American Psychological Association, September, 1980. Author's address: Social Relations Department, Price Hall #40, Lehigh University, Bethlehem, PA. 18015.

The Relationship among Localization Skill, Existence Constancy and Object Permanence

Linda Townes-Rosenwein, Lehigh University*

Recent experiments on existence constancy (E.C.), the ability of infants to expect that an object will continue to exist after it is hidden, and on localization skill (L.S.), the ability of infants to search in the correct place for a hidden object, have generated considerable interest (e.g., Goldberg, 1976; Moore, Borton & Darby, 1978; Butterworth, 1977; Bower, 1974; Cornell, 1979). These skills have been used as explanations for object permanence development (e.g., Butterworth, 1977; Evans & Gratch, 1972) and for general cognitive development in infancy (e.g., Harris, 1975; Moore & Meltzoff, 1978). Both component skills are interesting, because both are complex skills (incorporating motoric and memory aspects) which are theoretically meaningful and (at least heuristically) separable. Furthermore, both component skills are implicated in the development of object permanence, since both are necessary for solutions to object permanence problems.

These various experiments have generated many different theories and have had many different and, often, seemingly mutually contradictory outcomes (e.g., Acredolo, 1978; Schuberth, Werner & Lipsitt, 1978; Evans and Gratch, 1972; Bower, 1974; Moore, Borton & Darby, 1978). Thus, despite the importance of these skills to an understanding of infant cognitive functioning, it has been difficult to integrate this research.

The research can, however, be integrated, if one takes the theoretical

---

* Paper presented at the meeting of the American Psychological Association, September, 1980. Author's address: Social Relations Department, Price Hall #40, Lehigh University, Bethlehem, Pa.

approach that the young infant's cognitive organization may be inherently labile. Then, the research results may simply indicate that there is task lability for both skills. In fact, the research of a few experimenters already has demonstrated this problem for these skills in certain contexts (e.g., Avdzej & Aslin, 1977, studying visual tracking measures of E.C.; Uzgiris & Hunt, 1978, and also Acredolo, 1979, studying haptic measures of the locus of search).

Thus, in order to understand the relationship among these two component skills and object permanence, it is important to minimize the effects of task lability. As a start, it seems important to control four areas of task lability. First, we must avoid the problem of task variation when talking about the relationship of either skill to object permanence. Thus, the two component skills should be measured in traditional object pemanence problems, so that each skill (and object permanence, too) can be assessed in the same task. Second, we must avoid the problem of singling out a single task to stand for a whole concept, such as object permanence, whose measurement can be (and has been) assessed by a range of tasks. Thus, the two component skills should be measured in the whole range of traditional object permanence tasks given to the same infants. Third, we must avoid the problems individual differences cause for interpretation. Thus, we should measure both component skills within the same infants in order to understand the relationship among the skills within the individual. Fourth, we must avoid the problem of comparing different modalities. For example, many experiments studying E.C. use visual measures (e.g., Bower, Broughton, & Moore, 1971), while many experiments studying L.S. use haptic ones (e.g., Butterworth, 1977). Thus, there should be both visual and haptic measures of both component skills and of object permanence.

In object permanece assessment, we are fortunate in having a well-replicated series of tasks (Uzgiris & Hunt, 1975) which are generally agreed upon

and which are unaffected by small changes in scoring and presentation, as well as motivation levels (Townes-Rosenwein, 1980). Consequently, there are methodological,as well as theoretical, reasons why the measurement of the two component skills within traditional object permanence assessment procedures makes especially good sense.

The present study corrects these four design faults in previous work and presents a method of studying L.S. and E.C. in object permanence problems. These techniques are applied, first, to testing Piaget's theories about object permanence, and, second, to evaluating results obtained in non-traditional object permanence tasks.

Method

Eighty infants, randomly assigned to one of four groups (20 per group) and one of four counterbalanced orders of stimuli ,were tested at 4 and again at 8 months of age. Half of the group was male and half female. The infants were predominantly of lower-middle class backgrounds (skilled laborers, high school school educations), and virtually none were black. They were representative of the population in the small, steel manufacturing city in which they lived. Small, mutually discriminable toys were randomly assigned to each child.

The cloth tasks consisted of visible and invisible displacement trials. There were nine trials of each: under one cloth, under one of two cloths (the AB problem) and successively under one of three cloths. A box was used for invisible displacement hiding. The multiple tasks of each type involved controls for position biases (e.g., center versus side for trials using one cloth). The various controls are described in Miller, Cohen & Hill (1970). These cloth tasks encompassed Piaget's object permanence substages IV through VI. The tracking tasks involved following an object moving across the table top in front of the

infant. The moving object disappeared at the end of a trajectory. These tracking tasks emcompassed Piaget's object permanence substages II and III.[1] Presentation of the tasks generally followed Miller, Cohen & Hill (1970) and Uzgiris & Hunt (1975). Speed of the object along the track was 5.3 in./sec.

There were four groups differing in how much information about the object was available. The purpose of these groups was to assess the task lability of our measures of the skills within a setting which controlled the four types of lability discussed above. Thus, we would be able to tell whether small task changes substantially affected our measure of these skills. It already was known that there were significant differences in object permanence performance, both among experimental groups and between experimental and control groups (number of items passed, Townes-Rosenwein, 1977). It also was known that the structural relationship among the items remained unchanged (Townes-Rosenwein, 1979). Thus, the groups do seem to be situationally different, yet there is stability in the structure of the groups' object permanence results. Therefore, the groups can provide an adequate test of the task lability for the two component object permanence skills.

The four groups consisted of three experimental groups and a control group. In the experimental groups, the object was visually hidden during appropriate portions of the tracking and cloth tasks (i.e., behind a door at the end of the trajectory in the tracking tasks, and under the cloth(s) and in the box used for invisible displacement for the cloth permanence tasks). The first group, Regular (Reg), paralleled Piaget's traditional test situation, that is, no sound emanated from the object. In the second group, Sound (Sd), sound (xylophone tune) came out of the object throughout each task. In the third group, Intermittent Sound (IntSd), the xylophone tune continued to emanate from the object

only while the object was in view. This condition was designed to make sound information parallel to visual information during Piaget's traditional object permanence tasks, for which the view of the object disappears during hiding. In the fourth group, the Control group (Cont), the object was never hidden from the infant's view. Otherwise, trials in all groups duplicated those in the Reg group.

The infants were scored from videotapes. Measures of object permanence performance (adapted from Uzgiris & Hunt, 1975) were designed to make haptic and visual assessment parallel. Correlations among scores showed that this parallelism was achieved - correlations were higher between visual and haptic assessment of the same tasks than for same modality assessment of two different tasks.

Measures of L.S. and of E.C. were taken during the cloth tasks. Localization skill was measured by examining the order and location (the box, the various cloths) of infants' search. Top level L.S. without top level E.C. consisted of searching only at the correct location, but not exhibiting E.C. (not turning attention to the object after uncovering it). This definition of L.S. includes not only knowledge of the correct hiding location, but also the ability to translate this knowledge into correct visual or haptic search. Existence constancy was measured by examining whether infants turned attention to the object after uncovering it. Top level E.C. without top level L.S. consisted of searching first at the wrong place(s), eventually at the correct place, and then turning attention to the object after uncovering it. Thus, measurement criteria defined the skills as independent. Full solution to an object permanence problem required top level performance on both skills, i.e., searching only at the correct location and turning attention to the object after uncovering it. Parallel visual

and haptic measures of both L.S. and of E.C. were obtained.

Results[2]

The data indicated that we can have confidence in these new measures. First, interrater reliability was good (.9 or above). Second, no task lability occurred which was unrelated to Piagetian structural charactersitics of the tasks, i.e., the pattern of errors in the skills was similar among the groups. This result again seems to support the Piagetian notion that the cognitive structure among the tasks should remain unchanged in the Experimental conditions, even if the level of performance differed among the conditions. In fact, the data showed some groups' performance was better than others'. For instance, the Control group's performance (as expected intuitively, as well as predicted by Piagetian theory) was far superior (Kruskal Wallis one way analysis of variance $p < .01$) to that of any other group. There also were some small differences in the level of performance among the Experimental groups, but the Experimental groups were genrally similar to each other. Hence, Experimental group results were combined, while the Control group results will be reported separately. Finally, baseline measures of order and location of search before hiding showed that the order and location of search after hiding was not related to prior response tendencies in the absence of a hiding problem.

Since the data are reasonably stable, we can proceed to questions about Piagetian theory. Piaget would predict hierarchization of haptic skills in the Experimental groups. Hence Piaget would expect within-individual haptic patterns of skills to consist primarily of either possession of both E.C. and L.S. (which by our definition is equivalent to full object permanence solution) or possession of neither.[3] Table 1 shows that hierarchization occurred ($X^2 = p < .05$, two tailed).

However, analysis of the data on possession of one of the skills without the other yielded some interesting relationships among each component skill and object permanence. From the perspective of Piagetian theory, E.C. is logically closer to the core concept of object permanence than L.S. Therefore, E.C. should behave more like object permanence than L.S. I examined this question in several ways. First, I examined the age at which possession of each skill occurred in the Experimental groups. Table 1 shows that few instances of haptic E.C. possession (with or without possession of L.S.) occurred at 4 months of age (X^2 = $p < .05$, two tailed). The results on E.C. in the visual modality (X^2 = $p < .05$, two tailed) were equivalent. Thus, both object permanence and E.C.-without-L.S. solutions were largely absent (as predicted by Piaget) in the 4 month olds. On the other hand, Table 1 clearly shows that some large group of 8 month olds exhibits E.C.; this also was the case for the visual data. Thus, some 8 month olds are capable of both object permanence and E.C.-without-L.S. solutions. Another way of stating this is that the number of both object permanence and of E.C.-without-L.S. solutions per subject was virtually nil at 4 months of age (.1 for both object permanence and E.C.-without-L.S. for visual data, 0 for E.C.-without-L.S. and .1 for object permanence for haptic data). In comparison, both solutions were present at 8 months of age (2.2 for object permanence and 1.3 for E.C.-without-L.S. for visual data, 2.5 for object permanence and .6 for E.C.-without-L.S. for haptic data). For the Control condition, as may be expected, both E.C.-without-L.S. and object permanence solutions were present by 4 months of age.

Further, unlike object permanence results, solutions to L.S. occurred at 4 months for visual data. Table 2 shows significantly correct L.S. in the easiest tasks, two cloth visible displacement problems (binomial test, $p < .001$, two tailed). By 8 months of age, there is significant localization in both modalities in most

visible displacement trials. To state this point in terms of mean number of passes per subject, there 5.2 visual passes of L.S.-without-E.C. at 4 months of age, while virtually no visual object permanence passes (.1). There were virtually no haptic passes at 4 months of both L.S.-without-E.C. and of object permanence (.3 and .1 respectively). However, at 8 months passes of both object permanence and of L.S.-without-E.C. were present (for visual data 2.2 and 2.5 respectively, for haptic data 2.5 and .6 respectively). Control data show that, at both ages, there were few L.S.-without-E.C. solutions, since most children who were capable of L.S. solutions also were capable of E.C. solutions.

Thus, E.C.-without-L.S. solution was similar to object permanence solution in age of acquisition of skill, while L.S.-without-E.C. was not. Therefore, I examined Guttman scale results to see whether E.C. data also were more similar to object permanence results than L.S. data. Table 3 shows that there is less scaling (criterion of scaling was Guttman coefficient of reproducibility .9 or above, Green's index .5 or above) for Experimental groups in L.S.-without-E.C. visual analyses than in object permanence. Second, there is more scaling in the Control group for L.S.-without-E.C. than in object permanence. On the other hand, E.C.-without-L.S. scaling results were more similar to object permanence. Consequently, in Guttman scaling results, as well, E.C.-without-L.S. results were more similar to object permanence results than were L.S.-without-E.C. results.

Next, I examined condition effects among Experimental groups to see whether the same pattern occurred. Table 4 shows the condition effect for object permanence and for each component skill without the other. The object permanence effects were obtained by Kruskal Wallis one way analysis of variance. These results were treated as predictions to be tested by Mann-Whitney U's for each component skill without the other. Again, two major differences appear between

object permanence and L.S.-without-E.C. results. First, object permanence condition differences weren't significant at 4 months and were significant at 8 months, while the opposite was true for L.S.-without-E.C. Second, in the visual modality, there was a major shift in the order of conditions; the Sound group did best for L.S.-without-E.C. and worst for object permanence. For E.C.-without-L.S., on the other hand, like object permanence, condition effects were not significant at 4 months and were at 8 months and, like object permanence, the Intermittent Sound group did best. Results on the Control group did not differentiate among the two skills and object permanence. At 4 months, the Control group always did significantly better, except in L.S.-without-E.C. performance. However, the latter result only indicated that children in the Control group who possessed L.S. also possessed E.C. By 8 months of age, children in the Control group often were indicating possession of both component skills, so the number of solutions to a single component skill wasn't higher than that in the other groups.

Another question was whether the developmental relationship between E.C. and L.S. was consistent with Piaget's theory. Piaget would agree that L.S. can precede E.C. He views E.C. as a core concept of object permanence which, therefore, should appear about Stage IV (usually about 8-9 months of age). Furthermore, L.S. can be an extension of behaviors in progress, and thus Stage III. In contrast, E.C., as we have defined it, requires the "invention of new procedures" and also the removal of barriers to perception (necessary aspects of Stage IV solutions for Piaget, 1954). These latter are solutions characterisitic of more mature cognition, because the child must remove a cloth from the object (consequently removing a barrier to perception and inventing new means haptically) and then turn attention to the object without becoming distracted by the previous actions.

Thus, the fact that the data show L.S. can develop at a younger age than E.C. is consistent with Piagetian theory. However, it is important to note, as Table 1 shows, that the acquisition of L.S. does not invariably developmentally precede E.C. In fact, at 8 months, just as many infants are exhibiting E.C.-without-L.S. solutions as vice versa. This information indicates L.S. is not a necessary prerequisite of E.C. nor vice versa. The present data cannot precisely specify the relationship between E.C. and L.S. However, our data indicate that, in Flavell's terms (1972; Flavell & Wohlwill, 1969), the relationship is either one in which there is no functional relationship between the two (or only a remote relationship) or there is mediation between the two (facilitation of one by the other, or both facilitated by the same thing).

Finally, the data allow us to test Piaget's predictions of specific localization strategies during object permanence problems. These predictions are that infants below Stage V (our infants) should: 1) search first at the box and most of these infants also will search no further, and 2) search at side A on the B trials of the two (or three) cloth problems. Table 2 shows that the first of these predictions was confirmed (only for the easier invisible displacement tasks at 4 months), but not the second (binomial test $p < .05$, two tailed). At both ages, our data show there were no differences in B versus in A trials. The results of both modalities were similar (although L.S. was not significantly present in the 4 month olds' haptic data, and was in the visual data). It also is noteworthy that random searching was unusual at 8 months of age, and occurred only in hard tasks at 4 months (discounting the haptic floor effect at 4 months). Searching at more than one place occurred infrequently at both ages. Thus, it does not appear that children behave as if they expect the object to be equally likely to be found in all available places. Instead, they search significantly and immed-

iately at the correct place at 8 months when there is visible displacement, and at the box when there is invisible displacment. At 4 months of age, they search in the same places as at 8 months, but only for the easiest tasks; otherwise, their search is random.

Discussion

On balance, the data support Piaget's ideas about the relationship among object permanence, E.C., and L.S. However, since Piaget's discussion of these relationships lack detail, few precise predictions from his theory can be tested. More recent experiments have tried to examine these relationships in more detail. Each of the four sources of lability mentioned above, and controlled in the present study, provide a good framework for discussion of this recent work.

The first source of lability was the failure to measure L.S. and E.C. within traditional object permanence tasks. Traditional object permanence assessment (e.g., Uzgiris & Hunt, 1975) does not distinguish between E.C. and L.S. in evaluating level of achievement. A review of the literature shows that E.C. studies using rule violation in object permanence-like situations, and those using haptic and/or expressive (e.g., surprise) measures of object permanence performance in situations not very different from object permanece (e.g., Appel, 1971; LeCompte & Gratch, 1972; Saal, 1975; Charlesworth, 1966; Ramsey & Campos, 1975), provide more stable results than L.S. results. These studies also are consistent, in general, with our own E.C. results. Thus, both their results and our own show evidence of diffuse E.C. by 9-12 months of age. This fact does not mean that E.C. results are never labile. Visual measures of E.C., both using traditional object permanence problems (Kimball, 1970) and using tracking tasks (Avdzej & Aslin, 1977) do show lability. Perhaps the lability for these E.C. measures occurs because of perceptual versus conceptual definitions of E.C. and

object permanence (e.g., Butterworth, 1979; J.J. Gibson, Kaplan, Reynolds & Wheeler, 1969; Bower, 1975 on the perceptual side and Piaget, 1954, and Décarie, 1974, on the conceptual side). Whatever the truth in this theoretical dispute, it is important to note that the situations and measures of those on the perceptual side often are more labile than those on the conceptual side. On the other hand, studies on L.S., whether visually measured or not, whether situations are close to traditional object permanence tasks or not, continue in study after study to demonstrate considerable lability (e.g., Cornell, 1979; Schuberth et al., 1978; Riesner, 1979).

The second source of lability was the selection of only a single object permanence task through which to study L.S. and E.C. A large body of studies, both of L.S. (e.g., Bremner, 1978a) and of those pitting L.S. against E.C. (e.g., Evans & Gratch, 1972), has confined itself to the $A\overline{B}$ error in two cloth visible displacement problems. These studies usually also have restricted themselves to infants 8-10 months old. Probably, the reason for this focus is the fact that Piaget's account of object permanence lists the $A\overline{B}$ error as the first appearance in development of a localization error. These studies have produced varying results (Harris, 1975). Various factors have been shown to hinder or facilitate the appearance of the $A\overline{B}$ error: e.g., delay (facilitates, Gratch, Appel, Evans, LeCompte & Wright, 1974; Harris, 1973), near hiding location (hinders, Uzgiris & Lucas, 1978), markers and distinctive cover cues (hinders, Bremner, 1978b; Lucas & Uzgiris, 1977; Acredolo & Evans, 1979), two hiding places in view only on B trial (hinders, Gratch & Landers, 1971; Uzgiris & Hunt, 1975), and spatial array (for instance up-down array, Uzgiris & Lucas, 1978; Butterworth, 1976). The present study had two of these factors hindering the appearance of the $A\overline{B}$ error: lack of delay (like traditional procedures assessing

the whole range of object permanence, e.g., Uzgiris & Hunt, 1975), a necessary condition for appearance of the $A\overline{B}$ error (Schuberth et al., 1978), and near hiding location. These factors probably account for the lack of this error in the present study.

However, the premise of the present research is that the development of L.S. (and E.C.) and its (their) relationship to object permanence can only be understood if we examine the whole range of object permanence problems and study more than one age. Therefore, it is useful to examine the other cloth problems (except one cloth visible displacement problems) because all of these involve a change in the position of hiding in which at least two hiding locations are present (e.g., object hidden at center under cloth for first invisible displacement trial and at side for second), if not also a change in the cloth doing the hiding (e.g., B trial of invisible displacement and third trial of three cloth problems). Note that different spatial arrays still did not affect the data. Thus, by 8 months of age children continued to search correctly in visible displacement trials and at the box in invisible displacement trials. This pattern was not very different at 4 months, although at that age responses were at chance performance for harder visible and invisible displacement trials. The second trial of the one cloth invisible displacment problem is particularly instructive. For half of the infants, egocentric (self-referent, body-centered) spatial codes and allocentric (visual field) spatial codes (Butterworth, 1977) were identical to those of trial 1. Yet the infants did no better no trial 2 than 1, nor better than on the B trial of the two cloth invisible displacement task. Similarly, there was no difference between A and B trials for two cloth invisible displacement problems.[5] Butterworth's theory would predict that when egocentric and allocentric spatial codes are identical, localization errors should decrease.

Thus, our data are in conflict with both Butterworth's (1977) model of conflicting spatial frameworks and Harris' (1975) perseverative model which predicts search should be inaccurately divided between two locations or directed at both. In our data, directing search at more than one location occurred infrequently. The only significant results occurred in the visual modality. For these latter results, only one direction of search was significant - search first at the incorrect and then at the correct location - rather than both directions, as Harris would predict (see Table 2).

Instead, apparently the effect of localization errors at the box during invisible displacement is much stronger than that of the $A\overline{B}$ error. It is interesting to note that Cornell (1979), using quite a different procedure than usual object permanence testing, also found infants persevere more in response to container than position cues. He attributes his findings to learning, but a learning explanation makes less sense in the present study.

A third source of lability was the failure to study both component skills and object permanence within the same infants. There are no experiments that have phrased their questions about L.S. and E.C. in object permanence as comparisons of the two. Rather, there have been attempts to determine whether one or the other exclusively accounts for some object permanence phenomena (e.g., Evans & Gratch, 1972; Schuberth et al., 1978). These have foundered, as we have seen, because of the lability of localization behavior. The present emphasis on examining how both skills relate to each other indicates that localization ability is not a performance factor limiting E.C. acquisition, as some theorists might postulate, since E.C. can occur prior to L.S. acquisition. Furthermore, the within individual data show important relationships among the two skills and object permanence. A hierarchization model in relationship to object permanence

is supported. This model is consistent with Piaget's notion that cognition is hierarchical. The model also is consistent with his notion that the development of concepts of space and of existence of the object are both bound up together in the infant's cognition about objects. Finally, our data show a generally fluid and probabilistic relationship between the sequential acquisition of L.S. and E.C. This situation also is compatible with Piaget's theory and is characteristic of Wohlwill's (1973) hierarchical Model IV of development. Our data also are compatible with Fischer's (1979) model of cognitive development, as well as his approach of task analysis and concern with the meaning of lability.

The fourth source of lability was variation in modality measured. The literature shows particular instability for visual measures or visual task presentations without haptic measurement (e.g., Bower, Broughton & Moore, 1971; Goldberg, 1976; Avdzej & Aslin, 1977; Riesner, 1979). In traditional object permanence problems, visual responses still are somewhat labile. Thus, in our own study, binomial probability analyses of longitudinal stability (the notion that the same infants should do as well or better at an older age as they did at a younger age) showed longitudinal stability was lacking in the Experimental groups for visual measures of L.S.-without-E.C. It appears that visual search is more active and less fixed at 8 than 4 months. Hence, the same visual behaviors have different interpretations at the two ages. What may appear to be inaccurate or disrupted (Moore, Borton & Darby, 1978) visual search at 8 months may actually be more active and developmentally more mature, visual search. Caution, therefore, is indicated when interpreting visual search studies, especially of localization where cross-sectional data is used.

It is important to recognize that, throughout this report, we have heuristically defined L.S. and E.C. as separate from each other. Theoretically, they may not be. This controversy is related to the question of whether L.S. is a central conceptual problem for object permanence development, versus a peripheral problem theoretically separable from object permanence. There are several forms of the centrist position (e.g., Piaget, 1954; Harris, 1975; Uzgiris & Lucas, 1978; and Moore, Borton & Darby, 1978) and also several forms of the peripheral position (e.g., Bremner 1978b; Butterworth, 1976; Evans & Gratch, 1972; and Bremner & Bryant, 1977). Again, experimenters' reports provide claims and counterclaims about which explanation is correct (Acredolo, 1978; Schuberth et al., 1978; Evans & Gratch, 1972). Again, these experiments cannot resolve the issue because of the lability of the infants' responses. The present research does not attempt to answer this question, although the data do show that E.C. is a core concept of object permanence and that L.S. behaves somewhat differently than either E.C. or object permanence. Certainly, the hierarchization data indicates that both component skills are intertwined in the development of object permanence.

Many experimenters have noted a distinct where/what division in the nervous system (Pick & Saltzman, 1978). Often this division is considered similar to the observation that focal and ambient systems seem to be distinct, as well (Pick & Saltzman, 1978). Furthermore, those same sources report that ambient abilities developmentally precede focal ones. This is what our data show too, since L.S. in our study roughly corresponds to "where" and E.C. to "what". Thus, it seems reasonable, both on behavioral grounds (as we have shown by the differences between E.C. and L.S.) and on neurophysiological grounds, to continue (for the time being) treating the two component skills as separate skills which both contribute to object permanence development. Finally, both E.C. and L.S. themselves

may be composed of component skills which affect their relationship to each other. It may also be the case that a superordinate dimension, such as the ability to act on more than one thing at a time (Townes-Rosenwein, 1979), may underlie these skills.

In general, the results from the present study have several implications. First, they imply that our present knowledge is generally consistent with Piaget's theory, although part of the reason for this observation may be the lack of detail in his theory. Second, they imply that new theorizing about the relationships among object permanence, E.C. and L.S. is premature until there is more research on the effect of context, cues, behavioral maturity of responses, etc. on the solutions to these problems at various ages. Further longitudinal and cross-sectional research will have to clarify the effects of this lability on developmental sequences. For instance, Harris (1975) notes that older infants (12 months) may be more likely to make $A\overline{B}$ errors than younger ones (8 months). It is not surprising to find all this lability, since at 4-12 months of age, infants' concepts about space and E.C. probably also are labile (Uzgiris & Lucas, 1978). Note that the emphasis on lability is not merely a methodological issue, but also represents a theory about infants' cognitive development (see Fischer, 1979). In any case, this study has provided some new measures for E.C. and L.S. in a context where many sources of previous lability have been controlled and where more direct comparisons with object permanence can be made.

Directions for future research include, of course, a longitudinal exploration of these contexts, cues and response maturities at various ages. Certainly, many other component skills are part of the development of object permanence performance. Many of these also are important both theoretically and behaviorally, and any of these may influence the expression of L.S. and/or E.C. However, other

directions also appear fruitful. Tracking items have received widespread interest as measures of E.C., even if only of perceptual E.C. They also obviously involve L.S., since to solve tracking problems infants must follow the location of the object. Thus, an extension of the present study's approach to E.C. and L.S. in tracking tasks might help clarify the relationship between tracking and cloth permanence problems.

Next, studies of intermediate levels of performance in E.C. and L.S. may be helpful to understanding their development. The present study focused solely on pass/fail data, although many of the infants classified as "fail" clearly demonstrated some degree of the concept. Furthermore, the relationship between L.S. and E.C. probably changes at different points in development; experiments which extend the age range studied and which examine intermediate behaviors may be able to capture this complexity.

Finally, various new theoretical constructs related to E.C., L.S. and object permanence development such as perseveration (Harris, 1975), object identity (Moore & Meltzoff, 1978), featural identification (Bower, Broughton & Moore, 1971; Bower, 1974), as well as localization skill and existence constancy themselves, need definition if they are to be theoretically useful. For instance, do young infants perseverate at places of action,in search behavior itself thus searching everywhere, at salient landmarks, etc.? Most behavior in these search problems, correct or not, can be described as perseverative in some way, although the type of perseveration may differ. We know already that all forms of perseverative behavior are not affected similarly by task variables - for example, the $A\overline{B}$ error disappears when there is no delay, but "perseverative" search at the box does not. As another example, what is a feature? What aspects of a stimulus are not featural? Although E.C. and L.S. may not be vague concepts in the con-

fines of the traditional object permanence problem, they too may need clarification outside this context.

Footnotes

1. Five other tracking tasks similar to those given by Bower, Broughton & Moore (1971) and four habituation tasks also were interspersed randomly among the object permanence tasks.

2. Turning attention to the object was broken down into two categories: turns attention to the object any time after uncovering it, and turns attention to the object soon after uncovering it (time to attend to the object before hiding minus time to attend to the object after uncovering it $\leq$ 3 seconds). Since results were very similar on both measures, only one set of the results is reported.

3. Piaget, of course, selected solutions in the haptic modality as evidence of object permanence solutions to his cloth hiding problems, because these indicated an "invention of new procedures" (Piaget, 1954) to problems that were presented visually, rather than just an extension of visual responses.

4. Therefore, the data on possession of L.S. without possession of E.C. and vice versa necessarily are limited by small numbers, especially in the haptic modality.

5. Box placement was to the side (left or right, randomly) and cloth placement at the center on trial one of the one cloth invisible displacement tasks; box placement was at the center and cloth placement to the side (left or right, randomly). Box placement was at the center in all two cloth invisible displacement problems, and cloth placement was constant throughout. Box placement alternated between the two sides (starting randomly with the left or right side) in the three cloth invisible displacement trials, and cloth placement was constant throughout. Cloth placement was the same in visible displacement tasks as in invisible displacement tasks.

Bibliography

Acredolo, L. Development of spatial orientation in infancy. Developmental Psychology, 1978, 14, 224-234.

Acredolo, L. Laboratory versus home: the effect of environment on the 9-month-old infant's choice of spatial reference system. Developmental Psychology, 1979, 15, 666-667.

Acredolo, L. & Evans, D. Developmental changes in the effects of landmarks on infant spatial behavior. Paper presented at the meeting of the Society for Research in Child Development, San Francisco, 1979.

Appel, K. Three studies in object conceptualization: Piaget's sensorimotor stages four and five. Unpublished doctoral dissertation, University of Houston, 1971.

Avdzej, A. & Aslin, R. Visual tracking as an index of the object concept. Paper presented at the meeting of the Society for Research in Child Development, New Orleans, La., March 1977.

Bower, T.G.R. Development in Infancy. San Francisco: Calif.; Freeman & Co., 1974

Bower, T.G.R. Infant perception of the third dimension and object concept development. In L.B. Cohen & P. Salapatek (Eds.), Infant perception: from sensation to cognition (Vol. II, Perception of space, speech, and sound). New York: Academic Press, 1975.

Bower, T.G.R., Broughton, J., & Moore, M.K. Development of the object concept as manifested in changes in tracking behavior of infants between 7 and 20 weeks of age. Journal of Experimental Child Psychology, 1971, 11, 182-193.

Bremner, J.G. Spatial errors made by infants: inadequate spatial cues or evidence of egocentrism? British Journal of Psychology, 1978, 69, 77-84. (a)

Bremner, J.G. Egocentric versus allocentric spatial coding in nine-month-old infants: factors influencing the choice of code. Developmental Psychology, 1978, 14, 346-355. (b)

Bremner, J.G. & Bryant, P.E. Place versus response as the basis of spatial errors made by infants. Journal of Experimental Child Psychology, 1977, 23, 162-171.

Butterworth, G. Asymmetrical search errors in infancy. Child Development, 1976, 47, 864-867.

Butterworth, G. Object disappearnce and error in Piaget's Stage IV task. Journal of Experimental Child Psychology, 1977, 23, 391-401.

Butterworth, G. Logical competence in infancy: object percept or object concept? Paper presented at the meeting of the Society for Research in Child Development, San Francisco, March 1979.

Charlesworth, W. Development of the object concept: a methodological study. Paper presented at the meeting of the American Psychological Association, New York, September 1966.

Cornell, E. The effects of cue reliability on infants' manual search. Journal of Experimental Child Psychology, 1979, 28, 81-91.

Décarie, T. (In collaboration with J. Goulet, M. Brossard, S. Rafman, & R. Shaffran). The infant's reaction to strangers. (J. Diamanti, trans.). New York: International Universities Press, Inc., 1974 (Originally published, 1973).

Evans, W. & Gratch, G. The stage IV error in Piaget's theory of object concept development: difficulties in object conceptualization or spatial localization? Child Development, 1972, 43, 682-688.

Fischer, K. A theory of cognitive development: the control and construction of hierarchies of skills. Psychological Review, 1979, in press.

Flavell, J. An analysis of cognitive developmental sequences. Genetic Psychology Monographs, 1972, 86, 279-350.

Flavell, J. & Wohlwill, J. Formal and functional aspects of cognitive development. In D. Elkind & J. Flavell (Eds.), Studies in cognitive development: essays in honor of Jean Piaget. N.Y.: Oxford University Press, 1969.

Gibson, J.J., Kaplan, G., Reynolds, H., Jr., & Wheeler, K. The change from visible to invisible: a study of optical transitions. Perception and Psychophysics, 1969, 5, 113-116.

Goldberg, S. Visual tracking and existence constancy in 5-month-old infants. Journal of Experimental Child Psychology, 1976, 22, 478-491.

Gratch, G., Appel, K., Evans, W., LeCompte, G. & Wright, N. Piaget's stage IV object concept error: evidence of forgetting or object conception? Child Development, 1974, 45, 71-77.

*

Harris, P.L. Perseverative errors in search by young children. Child Development, 1973, 44, 28-33.

Harris, P.L. Development of search and object permanence during infancy. Psychological Bulletin, 1975, 82, 332-344.

Kimball, M. A comparison of motoric and perceptual measures of the development of the object concept in infancy (Doctoral dissertation, University of Michigan, 1970). Dissertation Abstracts International, 1971, 31, 7574B-7575B.

*Gratch, G. and Landers, W. Stage IV of Piaget's theory of infant's object concepts: a longitudinal study. Child Development, 1971, 42, 359-372.

LeCompte G. & Gratch, G. Violation of a rule as a method of diagnosing infants' levels of object concept. Child Development, 1972, 43, 385-396.

Lucas, T. & Uzgiris, I. Spatial factors in the development of the object concept. Developmental Psychology, 1977, 13, 492-500.

Miller, D., Cohen, L. & Hill, K. A methodological investigation of Piaget's theory of object concept development in the sensory-motor period. Journal of Experimental Child Psychology, 1970, 9, 59-85.

Moore, K.M., Borton, R., & Darby, B. Visual tracking in young infants: evidence for object identity or object permanence? Journal of Experimental Child Psychology, 1978, 25, 183-198.

Moore, M.K. & Meltzoff, A. Object permanence imitation, and language development in infancy: toward a neo-Pigetian perspective on communicative and cognitive development. In F.D. Minifie & L.L. Lloyd (Eds.), Communicative and cognitive abilities: early behavioral assessment. Baltimore, Md.: University Park Press, 1978.

Piaget, J. The construction of reality in the child (M. Cook, trans.). New York: Basic Books, Inc., 1954.

Pick, H. & Saltzman, E. Modes of perceiving and processing information. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1978.

Ramsay, D. & Campos, J. Memory by the infant in an object notion task. Developmental Psychology, 1975, 11, 411-412.

Riesner, J. Spatial orientation of six-month-old infants. Child Development, 1979, 50, 1078-1087.

Saal, D. A study of the development of object constancy in infancy by varying the degree of discrepancy between the disappearing and reappearing object. Unpublished doctoral dissertation, University of Houston, 1975.

Schuberth, R.E., Werner, J.S. & Lipsitt, L. Stage IV error in Piaget's theory of object concept development: a reconsideration of the spatial localization hypothesis. Child Development, 1978, 49, 744-748.

Townes-Rosenwein, L. Tracking, object permanence and the use of auditory information in relation to the object concept. Paper presented at the meeting of the Jean Piaget Society, Phila., Pa., May 1977.

Townes-Rosenwein, L. A multidimensional scaling approach to developmental dimensions in object permanence and tracking stimuli. Bethlehem, Pa.: Lehigh University, 1979. (ERIC Document Reproduction Service, in press).

Townes-Rosenwein, L. Investigations in the genesis of object permanence. Paper presented at the Child & Family Research Branch, NICHHD, Washington D.C., June 1980.

Uzgiris, I.& Hunt, J. McV. Assessment in infancy: ordinal scales of psychological development. Urbana, Ill. University of Illinois Press, 1975.

Uzgiris, I.& Lucas, T Observational and experimental methods in studies of object concept development in infancy. In Gene Sackett (Ed.), Observing behavior (Vol. I). Baltimore, Md.: University Park Press, 1978.

Wohlwill, J. The study of behavioral development. New York: Academic Press, 1973

Table 1

Number of Infants with Haptic Existency Constancy (EC), Localization Skill (LS), and Object Permanence Solutions (LS + EC)

4 Months

		one cloth (two trials)		two cloths Side A (two trials)		two cloths, Side B (one trial)		three cloths (four trials)	
		EC+	EC-[a]						
visible displacement	LS+	0	2	2	4	1	2	3	3
	LS-	-[b]	106	0	112	0	57	0	218
invisible displacement		1	6	0	0	0	0	0	2
		0	106	0	115	0	54	0	145

8 Months

visible displacement	LS+	50	5	27	6	14	5	36	11
	LS-	-[b]	61	4	79	2	37	11	172
invisible displacement		7	1	0	1	2	1	9	8
		2	104	2	108	1	52	7	181

NOTE. These data are experimental groups combined. Missing data were eliminated. Data are collapsed across similar trials, although X^2 were calculated for each individual trial. X^2 was $p \leq .001$, two-tailed for all trials except three cloths, trial 1 and where it was $p \leq .05$, two-tailed.

[a] EC+ = Existence constancy solution, EC- = absence of existence constancy solution, LS+ = localization skill solution, LS- = absence of localization skill.

[b] It wasn't possible to measure existence constancy without localization skill for one cloth visible displacement problems, since there was only one location in which to search.

Table 2
Order and Location of Search

		Visible Displacement			Invisible Displacement			
		Two Cloths Side A	Two Cloths Side B	Three Cloths	One Cloth	Two Cloths Side A	Two Cloths Side B	Three Cloths
4 months - visual	% find obj.[c]	59[b]	62	30	46	36	30	18
	search 'til find obj.[c]	NS	NS	NS	NS	*	***	*[d]
	search at one wrong place[c]	-***[a]	-***	NS	NS	NS	NS	-*[e]
	search first at box[c]	-	-	-	*[d]	***	***	NS
	only at box[c]	-	-	-	NS	**[f]	*	NS
4 months - haptic	% find obj.	6	5	2	6	0	0	1
	search 'til find obj.	NS	NS	NS	NS	NS	NS	NS
	search at one wrong place	NS	NS	NS	**	***		NS
	search first at box	-	-	-	**	***		NS
	search only at box	-	-	-	**	***		NS[g]
8 months - visual	% find obj.	53	43	43	64	20		16
	search til find obj.	NS	NS	NS	*	**[f]	NS	NS
	search at one wrong place	-*	-**	-**[d]	***	**	**	NS[g]
	search first at box	-	-	-	***	***	***	***[h]
	search only at box	-	-	-	***	***	***	*[h]
8 months - haptic	% find obj.	29	35	27	15	2	7	10
	search 'til find obj.	NS	NS	NS	NS	NS	NS	NS
	search at one wrong place	-**[d]	-***	-**	***	***	***	NS
	search first at box	-	-	-	***	***	***	***
	search only at box	-	-	-	***	***	***	***

Notes on the table continue on the following page.

Table 2 Continued

NOTE: These data are experimental groups combined. Significance values represent two-tailed binomial tests. Data are collapsed over similar trials, although binomial tests were carried out on each trial individually.

[a] *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$, NS = not significant, minus sign (-) before p value (as in -***) indicates the data came out significant in the opposite direction; this occurred for search at one wrong place, and means the subjects were searching significantly at the correct place.

[b] Average where more than one trial is involved.

[c] % find obj. = % infants who search either at first, or eventually, in the correct location. Search 'til find obj. = probability of searching first in incorrect place (s) and then in correct place, e.g. of persisting until one finds object. Search at one wrong place = probability of searching only at one wrong place. Search first at box = probabilty of searching first at box during invisible displacement problems whether or not one searches further. Search only at box = probability of searching only at the box during invisible displacement problems.

[d] trial one = NS, [e] trials one & two = NS, [f] trial two = NS [g] trial one = $p \leq .05$, [h] trial four = NS.

Table 3

Guttman Scaling of Object Permanence, Existence Constancy-without-Localization Skill, and Localization Skill-without-Existence Constancy

	Experimental Groups Tog.			Control Group		
	op[a]	EC-no-LS[a]	LS-no-EC[a]	OP	EC-no-LS	LS-no-EC
Modalities Separate						
all items[b]-vis	*.98(.77)[c]	-[d]	.88(.10)	.79(.32)	*.98(.75)	*.99(.86)
hap	*.97(.66)	-[d]	*1.0 (.94)	.76(.28)	.99(.85)	*.99(.91)
two items[b]-vis	*.97(.69)	*.98(.77)	.83(.07)	.74(0)	.90(.22)	*.98(.74)
hap	*.94(.41)	*1.0(.97)	*.99(.82)	.64(-)[c]	.93(.39)	*.96(.57)
one item[b]-vis	*.93(.53)	*.94(.51)	.73(.06)	.81(-)[c]	.75(-)	.84(-)
hap	.91(.31)	*.96(.55)	.90(.16)	.61(-)[c]	.82(.02)	.85(.02)
Visual Tracking-Haptic Cloth Items						
all items[b]	*.97(.74)	-[d]	*.99(.85)	.84(.49)	*.98(.75)	*.99(.90)
two items[b]	*.95(.53)	*.99(.88)	*.98(.74)	.71(.35)	.93(.39)	*.96(.54)
one item[b]	*.94(.54)	*.96(.59)	.91(.23)	.78(.07)	.84(.08)	.87(.13)

NOTE: The scale steps in these scales are: Stage II tracking, Stage III tracking, one cloth problems, two cloth problems, three cloth problems, one cloth invisible displacement problems, two cloth invisible displacement problems, three cloth invisible displacement problems. The EC-no-LS scales do not include one cloth problems because it is impossible to measure EC-no-LS when there is no alternative place to search. The scales involving visual tracking and haptic cloth items, of course, are measuring the items in the traditional modalities studied by Piaget.

[a] OP = object permanence, EC-no-LS = existence constancy without localization skill, LS-no-EC = localization skill without existence constancy.

[b] all items = all trials at that step are passed, two items--two items at that step are passed, one item--one item at that step is passed.

[c] * = scales with Guttman coefficient of reproducibility .9 or above and Green's index .5 or above. Guttman's coefficient is the first number and Green's index is in parentheses. (-) = Green's index is a minus number.

[d] - = there were no passes of the cloth item steps in these scales. Because of the hierarchization discussed above, there were small numbers of data points for solution to one component skill without the other.

Table 4

Differences among Conditions for Object Permanence, Existence Constancy-without-Location Skill, and Localization Skill-without Existence Constancy Solutions

	OP[c]	EC-no-LS[c]	LS-no-EC[c]
4 months-visual	NS[a] IntSd>Sd = Reg[b] floor effect	NS IntSd>Sd = Reg	Sd>Reg**[a] Sd>IntSd>Reg
4 months - haptic	NS IntSd>Sd = Reg floor effect	NS all zeros	IntSd>Sd*** IntSd>Reg>Sd
8 months - visual	$p \leq .02$ post hoc tests: IntSd>Sd $p < .05$ IntSd>Reg>Sd	IntSd>Reg * IntSd>Reg>Sd	NS Sd>Reg>IntSd
8 months - haptic	$p \leq .02$ post hoc tests: IntSd>Sd $p \leq .05$ Reg>Sd $p < .10$ Int Sd>Reg>Sd	IntSd>Reg** IntSd>Sd>Reg	NS IntSd>Reg>Sd

NOTE. The differences among conditions here involve the number of passes for experimental conditions only. Object permanence was first analyzed with Kruskal Wallis one way analysis of variance and post hoc comparisons. Then EC-no-LS and LS-no-EC were analyzed for comparison using Mann-Whitney U's.

[a] * = $p < .10$, one tail; ** = $p \leq .05$, one tail; NS=not significant; *** = $p \leq .025$, one tail. p values for OP results are written out in full.

[b] IntSd = intermittent Sound Group, Sd = Sound Group, Reg = Regular Group. These symbols indicate the relative numbers of passes in the three groups—here IntSd had the most, while Sd and Reg were equal.

[c] OP = object permanence solutions, EC-no-LS = existence constancy without localization skill solutions; LS-no-EC = localization skill without existence constancy solutions.